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54 **Refrigerant compositions.**

- 57 A refrigerant comprising a ternary or higher mixture of:
- (a) tetrafluoroethane and/or heptafluoropropane;
  - (b) difluoromethane and/or 1,1,1-trifluoroethane; and optionally
  - (c) pentafluoroethane.

**EP 0 509 673 A1**

This invention relates to refrigerants for cooling and heating applications, to refrigerant compositions containing them and to the use of such refrigerants in heat transfer devices, in particular refrigeration systems. The invention relates, in particular, to low temperature refrigerants, by which is meant refrigerants intended to achieve and maintain temperatures of the order of  $-30^{\circ}\text{C}$  and below, for example  $-50^{\circ}\text{C}$  and even  $-65^{\circ}\text{C}$ .

Mechanical refrigeration systems (and related heat transfer devices such as heat pumps and air-conditioning systems) are well known. In such systems, a refrigerant liquid evaporates at low pressure taking heat from the surrounding zone. The resulting vapour is then compressed and passed to a condenser where it condenses and gives off heat to a second zone, the condensate being returned through an expansion valve to the evaporator, so completing the cycle. Mechanical energy required for compressing the vapour and pumping the liquid is provided by, for example, an electric motor or an internal combustion engine.

In addition to having a suitable boiling point and a high latent heat of vaporisation, the properties preferred in a refrigerant include low toxicity, non-flammability, non-corrosivity, high stability and freedom from objectionable odour. Other desirable properties, particularly of low temperature refrigerants and refrigeration systems using them, are ready compressibility at pressures below 20 bars, low discharge temperature on compression, high refrigeration capacity, high efficiency (high coefficient of performance) and an evaporator pressure in excess of 1 bar.

Dichlorodifluoromethane (Refrigerant R-12) possesses a suitable combination of properties and has for many years been the most widely used refrigerant.

Dichlorodifluoromethane is, however, unsuitable for low temperature refrigeration applications, and chlorodifluoromethane (Refrigerant R-22), or the azeotrope thereof with chloropentafluoroethane (the azeotrope being Refrigerant R502), are usually used in such applications.

In recent years, however, there has been increasing international concern that fully and partially halogenated chlorofluorocarbons, such as dichlorodifluoromethane and chlorodifluoromethane, may be damaging the earth's protective ozone layer, and there is general agreement that their manufacture and use should be severely restricted and eventually phased out completely.

Whilst heat transfer devices of the type to which the present invention relates are essentially closed systems, loss of refrigerant to the atmosphere can occur due to leakage during operation of the equipment or during maintenance procedures. It is important, therefore, to replace fully and partially halogenated chlorofluorocarbon refrigerants by materials having zero ozone depletion potentials.

In addition to the possibility of ozone depletion, it has been suggested that significant concentrations of halocarbon refrigerants in the atmosphere might contribute to global warming (the so-called greenhouse effect). It is desirable, therefore, to use refrigerants which have relatively short atmospheric lifetimes as a result of their ability to react with other atmospheric constituents such as hydroxyl radicals.

According to the present invention there is provided a refrigerant which comprises a ternary or higher mixture of:

- (a) tetrafluoroethane and/or heptafluoropropane;
- (b) difluoromethane (HFC-32) and/or 1,1,1-trifluoroethane (HFC-143a); and optionally
- (c) pentafluoroethane (HFC-125).

The refrigerant of the invention will normally be formulated into a refrigerant composition which comprises, in addition to the refrigerant, one or more additives of the type which are conventionally used in refrigerant compositions. Particular mention may be made of a lubricant. The refrigerants of the invention are particularly suitable for use in low temperature refrigeration systems.

The tetrafluoroethane may be 1,1,1,2-tetrafluoroethane (HFC-134a) or 1,1,2,2-tetrafluoroethane (HFC-134) or a mixture of these two isomers. Preferably, however, the tetrafluoroethane is a single isomer, and more preferably is 1,1,1,2-tetrafluoroethane (HFC-134a). Therefore, in a preferred embodiment, component (a) is 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,2,2-tetrafluoroethane (HFC-134), heptafluoropropane, or a combination of heptafluoropropane and 1,1,1,2-tetrafluoroethane (HFC-134a) or 1,1,2,2-tetrafluoroethane (HFC-134).

The heptafluoropropane may be 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea) or 1,1,1,2,2,3,3-heptafluoropropane (HFC-227ca) or a mixture of these two isomers.

Although the refrigerant may comprise more than three of the above specified components, the refrigerant is preferably a ternary mixture. The mixture may be an azeotrope but will normally be zeotropic.

In one embodiment of the present invention, the refrigerant comprises a ternary or higher mixture of:

- (a) heptafluoropropane, optionally together with 1,1,1,2-tetrafluoroethane (HFC-134a) or 1,1,2,2-tetrafluoroethane (HFC-134);
- (b) at least one hydrofluorocarbon selected from difluoromethane (HFC-32) and 1,1,1-trifluoroethane

(HFC-143a); and optionally  
(c) pentafluoroethane (HFC-125).

Component (b) in the above embodiment preferably comprises or consists of difluoromethane (HFC-32). More preferably, component (b) is difluoromethane (HFC-32).

5 Such a refrigerant could provide a viable alternative to the chlorofluorocarbon refrigerants, such as Refrigerant R-22 and Refrigerant R-502, which have been used hitherto in commercial refrigeration systems and related heat transfer devices.

As stated above, ternary refrigerant mixtures are preferred. Accordingly, within this embodiment, particularly suitable refrigerants may be selected from:

- 10 (1) heptafluoropropane + 1,1,1,2-tetrafluoroethane (HFC-134a) + difluoromethane (HFC-32);  
(2) heptafluoropropane + 1,1,2,2-tetrafluoroethane (HFC-134) + difluoromethane (HFC-32);  
(3) heptafluoropropane + 1,1,1,2-tetrafluoroethane (HFC-134a) + 1,1,1-trifluoroethane (HFC-143a);  
(4) heptafluoropropane + 1,1,2,2-tetrafluoroethane (HFC-134) + 1,1,1-trifluoroethane (HFC-143a);  
(5) heptafluoropropane + difluoromethane (HFC-32) + 1,1,1-trifluoroethane (HFC-143a);  
15 (6) heptafluoropropane + difluoromethane (HFC-32) + pentafluoroethane (HFC-125); and  
(7) heptafluoropropane + 1,1,1-trifluoroethane (HFC-143a) + pentafluoroethane (HFC-125),

where the reference to heptafluoropropane is a reference to an individual isomer thereof.

A preferred heptafluoropropane containing refrigerant in the above list is that indicated under (6).

In a preferred embodiment of the present invention, the refrigerant comprises a ternary or higher  
20 mixture of:

- (a) 1,1,1,2-tetrafluoroethane (HFC-134a) or 1,1,2,2-tetrafluoroethane (HFC-134);  
(b) at least one hydrofluorocarbon selected from difluoromethane (HFC-32) and 1,1,1-trifluoroethane (HFC-143a); and optionally  
(c) pentafluoroethane (HFC-125).

25 Such a refrigerant could provide a particularly viable alternative to the chlorofluorocarbon refrigerants, such as Refrigerant R-22 and Refrigerant R-502, which have been used hitherto in commercial refrigeration systems and related heat transfer devices.

As stated above, ternary refrigerant mixtures are preferred. Accordingly, within this preferred embodiment, particularly suitable refrigerants may be selected from:

- 30 (8) 1,1,1,2-tetrafluoroethane (HFC-134a) + difluoromethane (HFC-32) + 1,1,1-trifluoroethane (HFC-143a);  
(9) 1,1,2,2-tetrafluoroethane (HFC-134) + difluoromethane (HFC-32) + 1,1,1-trifluoroethane (HFC-143a);  
(10) 1,1,1,2-tetrafluoroethane (HFC-134a) + difluoromethane (HFC-32) + pentafluoroethane (HFC-125);  
(11) 1,1,2,2-tetrafluoroethane (HFC-134) + difluoromethane (HFC-32) + pentafluoroethane (HFC-125);  
(12) 1,1,1,2-tetrafluoroethane (HFC-134a) + 1,1,1-trifluoroethane (HFC-143a) + pentafluoroethane (HFC-  
35 125); and  
(13) 1,1,2,2-tetrafluoroethane (HFC-134) + 1,1,1-trifluoroethane (HFC-143a) + pentafluoroethane (HFC-125).

A particularly preferred refrigerant comprises, and preferably consists essentially of:

- 40 (a) 1,1,1,2-tetrafluoroethane (HFC-134a) or 1,1,2,2-tetrafluoroethane (HFC-134), especially 1,1,1,2-tetrafluoroethane (HFC-134a);  
(b) difluoromethane (HFC-32) or 1,1,1-trifluoroethane (HFC-143a), especially difluoromethane (HFC-32);  
and  
(c) pentafluoroethane (HFC-125).

Such refrigerants are seen as providing an especially viable alternative to Refrigerants R-22 and R-502  
45 which have been used hitherto in commercial refrigeration systems and related heat transfer devices.

Low temperature refrigerants in accordance with the invention typically contain from 5 to 95% by weight of tetrafluoroethane or heptafluoropropane and from 95 to 5% by weight of the other component or components. The refrigerant may comprise other suitable refrigerant compounds, for example other hydrofluoroalkanes and/or fluorinated ethers. Generally, however, the refrigerant will only contain the  
50 hydrofluorocarbons specified above.

The amounts of the various components in the refrigerant may vary within wide limits, and may be selected so as to provide a composition meeting the design requirements of any particular refrigeration system. Thus, for example, varying the relative proportions of the components of a particular mixture in a particular refrigeration system affects such parameters as boiling point of the mixture, condenser pressure, evaporator pressure, discharge temperature, system efficiency (coefficient of performance, by which is  
55 meant the ratio of cooling duty achieved to mechanical power supplied to the compressor) and refrigeration capacity (compressor swept volume per unit of cooling duty). In general, increasing the proportion of difluoromethane in a composition lowers the temperature achieved and maintained by the refrigeration

system, whilst increasing the proportion of 1,1,1,2-tetrafluoroethane reduces the discharge temperature.

The Tables below show the parameters of a number of refrigerants according to the invention, and compares these with the parameters of the presently used refrigerants R-22 and R-502. All the refrigerants examined were ternary mixtures of difluoromethane (HFC-32), 1,1,1,2-tetrafluoroethane (HFC-134a) and pentafluoroethane (HFC-125). The percentage by weight of each of the components in the refrigerant are given in the top row of each Table. For example, 30/50/20 signifies a refrigerant containing 30 % by weight HFC-32, 50 % by weight HFC-134a and 20 % by weight HFC-125. In the Tables, the glide in the evaporator represents the temperature range over which the refrigerant boils in the evaporator.

The Tables show that refrigerants according to the invention can exhibit parameters similar to those of R-22 and R-502 which they could replace. It will be appreciated that for any particular refrigeration application and system, a refrigerant according to the invention can be designed to achieve the performance criteria of condenser pressure not greater than 20 bars, evaporator pressure greater than 1 bar and compressor discharge temperature below the maximum operating temperature of any lubricant contained in a refrigerant composition in which the refrigerant of the invention is incorporated.

The present invention is particularly concerned with the provision of replacement refrigerants for Refrigerants R-22 and R-502, especially the latter, which are at present widely used in commercial heat transfer devices such as refrigeration systems.

The preferred refrigerant of the invention for replacing Refrigerant R-22 is a mixture comprising, and preferably consisting essentially of:

- (a) 1,1,1,2-tetrafluoroethane (HFC-134a);
- (b) difluoromethane (HFC-32); and
- (c) pentafluoroethane (HFC-125).

An especially preferred refrigerant of the invention for replacing Refrigerant R-22 is a ternary mixture consisting essentially of:

- (a) 55 to 65 % by weight of 1,1,1,2-tetrafluoroethane (HFC-134a);
- (b) 25 to 35 % by weight of difluoromethane (HFC-32); and
- (c) 5 to 15 % by weight of pentafluoroethane (HFC-125).

The preferred refrigerant of the invention for replacing Refrigerant R-502 is a mixture comprising, and preferably consisting essentially of:

- (a) 1,1,1,2-tetrafluoroethane (HFC-134a);
- (b) difluoromethane (HFC-32); and
- (c) pentafluoroethane (HFC-125).

A suitable replacement for Refrigerant R-502 may be a mixture comprising a 1:1:1 molar ratio of the above components.

One particularly preferred refrigerant of the invention for replacing Refrigerant R-502 is a ternary mixture consisting essentially of:

- (a) 25 to 55 % by weight, preferably 26 to 55 % by weight of 1,1,1,2-tetrafluoroethane (HFC-134a);
- (b) 25 to 55 % by weight, preferably 26 to 55 % by weight of difluoromethane (HFC-32); and
- (c) 5 to 45 % by weight of pentafluoroethane (HFC-125).

Such a refrigerant can provide a good compromise between the various performance criteria which are desirable for a refrigerant which is intended to replace Refrigerant R-502. Advantageously, however, such a refrigerant can provide a higher refrigeration capacity, i.e a higher cooling duty per unit swept volume, than Refrigerant R-502. Such a refrigerant can also provide a better energy efficiency than Refrigerant R-502 as indicated by a higher value for the coefficient of performance. These effects are illustrated in Tables 2 and 3 by refrigerants 5 to 8.

Another particularly preferred refrigerant of the invention for replacing Refrigerant R-502 is a ternary mixture consisting essentially of:

- (a) 5 to 25 % by weight, preferably 5 to 24 % by weight of 1,1,1,2-tetrafluoroethane (HFC-134a);
- (b) 25 to 75 % by weight, preferably 26 to 75 % by weight of difluoromethane (HFC-32); and
- (c) 15 to 65 % by weight of pentafluoroethane (HFC-125).

Such a refrigerant can provide a considerably higher refrigeration capacity, i.e a considerably higher cooling duty per unit swept volume, than Refrigerant R-502. This effect is illustrated in Tables 3, 4 and 5 by refrigerants 9 to 12, 13 and 15.

An especially preferred refrigerant of the invention for replacing Refrigerant R-502 is a ternary mixture consisting essentially of:

- (a) 5 to 45 % by weight of 1,1,1,2-tetrafluoroethane (HFC-134a);
- (b) 15 to 25 % by weight, preferably 15 to 24 % by weight of difluoromethane (HFC-32); and
- (c) 35 to 75 % by weight of pentafluoroethane (HFC-125).

Such a refrigerant can provide a good balance between the various performance criteria which are desirable for a refrigerant which is intended to replace Refrigerant R-502. In other words, the performance characteristics of Refrigerant R-502 can be matched reasonably closely by a refrigerant having the composition specified above. This effect is illustrated in Tables 1 and 2 by refrigerants 2 to 4.

5 All the percentages by weight quoted above are based on the total weight of the refrigerant mixture.

The refrigerant and the compositions containing them may be prepared by a simple mixing process.

As stated above the refrigerant may and usually will be formulated into a refrigerant composition together with a lubricant. Any conventional lubricant may be employed, but polyalkylene glycols and especially esters are preferred. By selecting a lubricant with a high thermal stability, it is possible to operate  
10 with higher compressor discharge temperature than is currently possible using conventional hydrocarbon lubricants and this can improve the thermodynamic efficiency of the refrigeration system.

The refrigerants are useful in all types of compression cycle heat transfer devices. Thus, they may be used to provide cooling by a method involving condensing the refrigerant and thereafter evaporating it in a heat exchange relationship with a body to be cooled. They may also be used to provide heating by a  
15 method involving condensing the refrigerant in a heat exchange relationship with a body to be heated and thereafter evaporating it. The refrigerants are also useful in counter-current heat exchangers to increase the efficiency of such exchangers.

The refrigerants of the invention provide a good compromise between efficiency and low atmospheric lifetime combined with non-flammability and zero ozone depletion. They are especially suitable for  
20 applications currently satisfied by Refrigerants R-22 and R-502.

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TABLE 1

Evaporator Temperature: -32°C (Mid) Cooling Duty: 100 KW Compressor Efficiency: 80%  
 Condensing Temperature: +43°C (Mid) Return Gas Temperature: 18°C

	UNITS	R22	R502	1 32/134a/125 30/50/20	2 32/134a/125 20/40/40	3 32/134a/125 20/30/50
CONDENSER PRESSURE	Bar	16.56	17.96	18.33	18.67	19.91
EVAPORATOR PRESSURE	Bar	1.50	1.85	1.56	1.62	1.78
DISCHARGE TEMPERATURE	°C	161.21	125.92	143.36	132.37	130.94
VOLUMETRIC FLOW	M³/S	0.130	0.145	0.144	0.154	0.149
COOLING DUTY PER UNIT SWEPT VOLUME	KJ/m³	767	687	695	651	671
COEFFICIENT OF PERFORMANCE		1.46	1.19	1.27	1.18	1.12
BUBBLE POINT BOILING POINT	°C	-41	-46	-44.85	-45.45	-46.97
DEW POINT				-37.77	-38.80	-41.10
GLIDE IN EVAPORATOR	°C	0	0	4.03	3.59	3.26

TABLE 2

Evaporator Temperature: -32°C (Mid) Cooling Duty: 100 KW Compressor Efficiency: 80%  
 Condensing Temperature: +43°C (Mid) Return Gas Temperature: 18°C

	UNITS	R22	R502	4 32/134a/125 20/20/60	5 32/134a/125 40/50/10	6 32/134a/125 40/30/30
CONDENSER PRESSURE	Bar	16.56	17.96	21.20	19.06	21.34
EVAPORATOR PRESSURE	Bar	1.50	1.85	1.94	1.62	1.89
DISCHARGE TEMPERATURE	°C	161.21	125.92	129.81	153.31	151.14
VOLUMETRIC FLOW	M <sup>3</sup> /S	0.130	0.145	0.147	0.134	0.125
COOLING DUTY PER UNIT SWEPT VOLUME	KJ/m <sup>3</sup>	767	687	679	748	798
COEFFICIENT OF PERFORMANCE		1.46	1.19	1.06	1.30	1.21
BUBBLE POINT	°C	-41	-46	-48.42		
BOILING POINT DEW POINT	°C			-43.76		
GLIDE IN EVAPORATOR	°C	0	0	2.63	4.23	3.57

TABLE 3

Evaporator Temperature: -32°C (Mid) Cooling Duty: 100 KW Compressor Efficiency: 80%  
 Condensing Temperature: +43°C (Mid) Return Gas Temperature: 18°C

	UNITS	R22	R502	7 32/134a/125 30/30/40	8 32/134a/125 50/30/20	9 32/134a/125 50/20/30
CONDENSER PRESSURE	Bar	16.56	17.96	20.75	21.73	22.94
EVAPORATOR PRESSURE	Bar	1.50	1.85	1.84	1.94	2.11
DISCHARGE TEMPERATURE	°C	161.21	125.92	141.43	160.38	158.76
VOLUMETRIC FLOW	M <sup>3</sup> /S	0.130	0.145	0.136	0.117	0.112
COOLING DUTY PER UNIT SWEPT VOLUME	KJ/m <sup>3</sup>	767	687	736	855	889
COEFFICIENT OF PERFORMANCE		1.46	1.19	1.17	1.25	1.22
BUBBLE POINT BOILING POINT DEW POINT	°C	-41	-46			
GLIDE IN EVAPORATOR	°C	0	0	3.48	3.56	2.79



TABLE 4

Evaporator Temperature: -32°C (Mid) Cooling Duty: 100 KW Compressor Efficiency: 80%  
 Condensing Temperature: +43°C (Mid) Return Gas Temperature: 18°C

	UNITS	R22	R502	10 32/134a/125 40/20/40	11 32/134a/125 50/10/40	12 32/134a/125 40/10/50
CONDENSER PRESSURE	Bar	16.56	17.96	22.73	24.29	24.13
EVAPORATOR PRESSURE	Bar	1.50	1.85	2.05	2.28	2.25
DISCHARGE TEMPERATURE	°C	161.21	125.92	150.17	157.57	148.49
VOLUMETRIC FLOW	M³/S	0.130	0.145	0.122	0.109	0.118
COOLING DUTY PER UNIT SWEEP VOLUME	KJ/m³	767	687	819	913	845
COEFFICIENT OF PERFORMANCE		1.46	1.19	1.16	1.17	1.11
BUBBLE POINT BOILING POINT DEW POINT	°C	-41	-46			
GLIDE IN EVAPORATOR	°C	0	0	2.82	1.65	1.70

TABLE 5

Evaporator Temperature: -32°C (Mid) Cooling Duty: 100 KW Compressor Efficiency: 80%  
 Condensing Temperature: +43°C (Mid) Return Gas Temperature: 18°C

	UNITS	R22	R502	13 32/134a/125 30/10/60	14 32/134a/125 20/10/70	15 32/134a/125 70/10/20
CONDENSER PRESSURE	Bar	16.56	17.96	23.41	22.77	24.88
EVAPORATOR PRESSURE	Bar	1.50	1.85	2.21	2.14	2.32
DISCHARGE TEMPERATURE	°C	161.21	125.92	138.20	128.49	176.81
VOLUMETRIC FLOW	M <sup>3</sup> /S	0.130	0.145	0.129	0.146	0.099
COOLING DUTY PER UNIT SWEPT VOLUME	KJ/m <sup>3</sup>	767	687	776	683	1010
COEFFICIENT OF PERFORMANCE		1.46	1.19	1.06	0.98	1.23
BUBBLE POINT BOILING POINT DEW POINT	°C	-41	-46			
GLIDE IN EVAPORATOR	°C	0	0	1.71	1.62	1.50

## Claims

1. A refrigerant comprising a ternary or higher mixture of:
  - (a) tetrafluoroethane and/or heptafluoropropane;
  - (b) difluoromethane and/or 1,1,1-trifluoroethane; and optionally

(c) pentafluoroethane.

2. A refrigerant as claimed in 1, wherein component (a) is 1,1,1,2-tetrafluoroethane, 1,1,2,2-tetrafluoroethane, heptafluoropropane, or a combination of heptafluoropropane and 1,1,1,2-tetrafluoroethane or 1,1,2,2-tetrafluoroethane.  
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3. A refrigerant as claimed in claim 1 or claim 2, wherein component (a) is heptafluoropropane, optionally together with 1,1,1,2-tetrafluoroethane or 1,1,2,2-tetrafluoroethane.
- 10 4. A refrigerant as claimed in claim 3, wherein component (b) is difluoromethane.
5. A refrigerant as claimed in claim 3 or claim 4 which comprises pentafluoroethane.
6. A refrigerant as claimed in claim 1 or claim 2, wherein component (a) is 1,1,1,2-tetrafluoroethane or 1,1,2,2-tetrafluoroethane.  
15
7. A refrigerant as claimed in claim 6, wherein component (a) is 1,1,1,2-tetrafluoroethane.
8. A refrigerant as claimed in claim 6 or claim 7, wherein component (b) is difluoromethane.  
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9. A refrigerant as claimed in any one of claims 6 to 8 which comprises pentafluoroethane.
10. A refrigerant comprising:  
25 (a) 1,1,1,2-tetrafluoroethane;  
(b) difluoromethane; and  
(c) pentafluoroethane.
11. A refrigerant as claimed in claim 10, wherein 1,1,1,2-tetrafluoroethane constitutes from 25 to 55 % by weight, difluoromethane constitutes from 25 to 55 % by weight, and pentafluoroethane constitutes from 5 to 45 % by weight of the total weight of the refrigerant.  
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12. A refrigerant as claimed in claim 10, wherein 1,1,1,2-tetrafluoroethane constitutes from 5 to 25 % by weight, difluoromethane constitutes from 25 to 75 % by weight, and pentafluoroethane constitutes from 15 to 65 % by weight of the total weight of the refrigerant.  
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13. A refrigerant as claimed in claim 10, wherein 1,1,1,2-tetrafluoroethane constitutes from 5 to 45 % by weight, difluoromethane constitutes from 15 to 25 % by weight, and pentafluoroethane constitutes from 35 to 75 % by weight of the total weight of the refrigerant.
- 40 14. A refrigerant composition comprising a refrigerant as claimed in any one of claims 1 to 13 and a lubricant.
15. A heat transfer device in which the working fluid comprises a refrigerant as claimed in any one of claims 1 to 13 or a refrigerant composition as claimed in claim 14.  
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16. A method for providing cooling which comprises condensing the refrigerant claimed in any one of claims 1 to 13 and thereafter evaporating it in a heat exchange relationship with a body to be cooled.
17. A method for providing heating which comprises condensing the refrigerant claimed in any one of claims 1 to 13 in a heat exchange relationship with a body to be heated and thereafter evaporating it.  
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European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number

EP 92 30 2837

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
P,X	WO-A-9 201 762 (DU PONT DE NEMOURS) * abstract; claim 1; table 3 * ---	1-17	C09K5/04
P,X	EP-A-0 430 169 (MATSUSHITA) * abstract; claims 1-17; figure 7; example 7 * ---	1-14	
P,X	WORLD PATENTS INDEX LATEST Derwent Publications Ltd., London, GB; AN 91-262358 & JP-A-3 170 588 (MATSUSHITA) 24 July 1991 * abstract * ---	1-17	
A	WORLD PATENTS INDEX LATEST Derwent Publications Ltd., London, GB; AN 89-035371 & JP-A-63 308 084 (ASAHI GLASS) 15 December 1988 * abstract * -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			C09K
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26 MAY 1992	Examiner NICOLAS H. J. F.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document			

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